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PARTICULATE FILTER FOR AN INTERNAL COMBUSTION ENGINE

The invention refers to a particulate filter for an internal combustion engine, comprising a monolithic porous filter body with inflow channels and outflow channels, each inflow channel crossing at least one outflow channel from which it is separated by a filtering wall.

It is known to pass the exhaust gases of Diesel engines through a Diesel particulate filter that retains the solid particles. The carbon particulate matter that accumulates in the Diesel particulate filter is burned to ash in intervals. Such Diesel particulate filters have an operating temperature on the order of 500°C. Ceramics and sintered bodies are available for their manufacture. Conventional particulate filters comprise a monolithic filter body of porous material including longitudinally extending channels. Alternately, these channels are closed at the one end or the opposite other end. Two adjacent channels respectively form an inflow channel and an outflow channel. The filter flow passes through the wall separating both channels from each other. The manufacturing method, presently available only for ceramics, uses the extrusion of a ceramic mass. Here, only profile structures of the channels can be realized, wherein the inflow channels and the outflow channels extend in parallel to each other. A respective channel is closed at one end by a purposeful deformation of the channel wall.

This is due to the fact that greater temperature differences and thus higher thermal tensions occur with larger dimensions. This means that a Diesel particulate filter suited for a compact car cannot be transformed to a size suited for larger cars or even trucks simply by scaling it up. Finally, there is no easily maintainable and compact solution to the problem of removing the ash resulting from the combustion process.

DE 30 43 996 A1 describes an airborne particles filter for Diesel engines, through which filter exhaust gases flow. The airborne particles filter is arranged in a tubular housing in an exhaust pipe behind the exhaust collection box. Within the housing, the airborne particles filter comprises a ceramic filter element in the form of a monolith having inflow channels and outflow channels. The inflow channels extend in parallel to each other on several parallel planes and the outflow channels extend in the intermediate planes such that they cross the inflow channels. The monolith is mounted in the housing such that the outflow channels are perpendicular and their upper ends are closed, whereas the lower end are in

communication with the outlet pipe. The inflow channels are open at both ends and receive, from opposite sides, the exhaust gases from the exhaust collecting boxes of the engine. The carbon particulate matter thus remains in the inflow channels.

It is an object of the invention to provide a particulate filter for an internal combustion engine that is capable of cleaning voluminous exhaust flows charged with oxidizable particles.

The present particulate filter has the features of claim 1. According thereto, the inflow channels open into a settling chamber which is an ash chamber for depositing the ash.

In the present filter, the gas flow path passes through the porous wall between an inflow channel and a plurality of outflow channels, while the ash remains in the inflow channel and can be removed therefrom either continuously or in a separate cleaning process. At the outlet end of the inflow channels, a counter pressure is built up to cause the gases to pass through the porous walls. The counter pressure is generated by the fact that the inflow channels open into a closed chamber. The ash chamber in which the ash is collected, may be chosen large enough to be able to accommodate all the ash accumulated during a filter's service life. Alternatively, the ash chamber may also have a cleaning opening through which ash can be removed.

The inflow and outflow channels crossing each other effect a distribution of the exhaust flow from each inflow channel to a plurality of outflow channels. The inflow channels not only have open inlets, but also open outlets. The particles contained therein can thus be transported to the outlet. The inflow channels are no one-way street for the ash particles formed. Thus, it is possible to keep the pores substantially free and to avoid or delay an obstruction of the filter.

While regeneration in conventional filters has the disadvantage that highly excessive temperatures can occur in the end portion of the filter, the invention avoids this effect. Because of the crossing flow paths no thermal wave running through the filter is created.

Due to the crossing channels, the filter body cannot be made in a manufacturing method by extrusion or the like. The channel walls are made of porous ceramics (SiC, $A1_20_3$,...) or metal sintered materials which catch the entrained solid particles as gases flow through and filter them from the gases. The gas passing through the wall is discharged from

the monolithic solid body under an angle of > 1° with respect to the inflow channels. Crossing the inflow channels and the outflow channels means that the flows are at a random angle to each other that is different from zero.

The inflow channels and/or the outflow channels may have any cross-sectional shape, e.g. a round, triangular or quadrangular cross section.

The complex monolithic filter body may be manufactured according to special manufacturing methods, e.g. in a Direct Typing Process, wherein layers of pasty materials that have different patterns are layered upon each other using a screen-printing machine.

In a preferred embodiment of the invention, the inflow channels are tubes passing through chambers without their walls contacting each other, the chambers forming the outflow channels. Thus, it is achieved that the entire circumferential surface of the inflow channels is available as a filter surface. In this manner, a relatively large filter surface is realized in a volume.

The following is a detailed description of embodiments of the invention with reference to the drawings. This explanation is not be construed as limiting the scope of the invention. Rather, the scope is determined by the claims.

In the Figures:

Fig. 1 is a schematic illustration of a longitudinal section through a first embodiment of the particulate filter,

Fig. 2 shows a section along line II-II in Figure 1, and

Fig. 3 is a perspective schematic illustration of a second embodiment in which the inflow channels pass through chambers.

The particulate filter illustrated in Figures 1 and 2 is a Diesel particulate filter for a Diesel engine. It comprises an integral porous filter body 10 accommodated in a tube 11 and filling one half of the tube, for example. The filter body 10 is made of a porous material, especially of ceramics or sintered metal. It has a high thermal resistance of at least 1500°C.

Formed in the filter body 10 is a plurality of longitudinally extending inflow channels 12 that are shown in light color in Figure 2. In this case, the inflow channels are of

rectangular cross section and are defined by circumferential walls. One set of inflow channels 12 is respectively disposed in a common plane. Located between two adjacent planes of inflow channels 12 is a respective plane of outflow channels 13. The inflow channels and the outflow channels are arranged such that they cross each other. In the present embodiment, they run at right angles to each other. Filtering walls are situated between one set of inflow channels 12 and an outflow channel 13. Of the four walls defining an inflow channel 12, only two walls act as filtering walls in this embodiment, namely those walls that separate the inflow channel 12 from the adjacent outflow channels 13. The two other walls have no function.

The inflow channels 12 extend linearly through the filter body 10 from an inlet end 14 to an outlet end 15. In the tubular housing 11, the outlet end 15 is followed by a pressure-tightly closed settling chamber 17 which is an ash chamber. In the settling chamber, the flow velocity is reduced substantially and the ash is deposited. The inflow channels 12 open into the chamber 17 in which a pressure builds up. The ash 18 that has been formed in the inflow channels 12 and have reached the chamber 17 due to vibrations also accumulate there. The chamber 17 may include a flap for removing the ash 18.

Above the filter body 10, a chamber 20 is provided in the housing 11, which extends along the entire length of the housing 11. The outflow channels 13 of the filter body 10 open into this chamber 20. The chamber 20 has an outlet opening 21 through which the cleaned gases escape.

In operation as a Diesel particulate filter, the vehicle exhaust gases that are indicated by the arrows 23 are fed to the inflow channels 12. The carbon particulate matter settles in the filter body 10, whereas the gases flow through the filtering walls into the outflow channels 13 and from there into the chamber 20.

To regenerate the filter body 10, the same is heated so that the carbon particulate matter oxidizes and burns to ash. Thereby, the pores of the filtering walls are cleared again. Vehicle vibrations and the effect of the gas flow transport the ash into the chamber 17.

Whereas in the first embodiment only two of the four walls of each inflow channel 12 act as filtering walls, all four walls of the embodiment in Figure 3 are filtering walls. In this embodiment, the inflow channels 12 extend as rectangular tubes from an inlet end 14 to an

outlet end 15. The outlet end 15 leads to a closed chamber (not illustrated) which may be configured as an ash chamber.

Along the length of the inflow channels 12, the filter body is divided into chambers 28, 29 by transverse walls 25, 26 and 27, which chambers form the outflow channels 13. the cleaned gases 30 leave the filter body and reach a collecting chamber (not illustrated).

It can be seen in Figure 3 that each inflow channel has four filtering walls W1, W2, W3 and W4. This is possible because the tubular inflow channels 12 are spaced apart from each other. The walls 25, 26 and 27 also serve to mechanically hold the inflow channels 12.

The function of the Diesel particulate filter of Figure 3 is the same as that of the first embodiment so that the description thereof will not be repeated.